

LA-UR-02-7481

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used in Contact Ionization Sources

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Submitted to: 2003 Particle Accelerator Conference
May 12-16, 2003
Portland, Oregon



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Form 836 (8/00)

***Diffusion of Alkali Species in Porous Tungsten Substrates
used in Contact-Ionization Sources****

E. Chacon-Golcher¹, J.W. Kwan² and E. C. Morse³

Submitted to the 2003 Particle Accelerator Conference

Abstract

Contact ionization (doped) sources used in current Heavy Ion Fusion experiments consist of a porous tungsten substrate doped with an alkali carbonate. In the early stages of the heating cycle ($T \sim 600^\circ\text{C}$), the carbonate breaks down and releases the alkali atoms that then diffuse through the substrate. At the emitter surface there is a balance between the fast desorption rate of the alkali atoms (mostly as neutrals) and the slower replenishment rate from the substrate by diffusion. Time-resolved measurements of neutral particle evaporation rates at the emitter surface have been used to estimate the effective diffusion coefficient (D) that characterizes the migration of alkali species in the substrate. These estimates are consistent with the observed source lifetimes (tens of hrs.) and establish the alkali migration in the bulk as a diffusion-limited process. The measurements suggest that the faster migration rates ($D \approx 10^{-5} - 10^{-6} \text{ cm}^2/\text{s}$) occur early during the heating cycle when the dominant species are the neutral alkali atoms. At operating temperatures there is a slower migration rate ($D \approx 10^{-7} \text{ cm}^2/\text{s}$) due to the dominance of ions, which diffuse by a slower surface diffusion process.

* This work has been performed under the auspices of the US DOE by UC-LBNL under contract DE-AC03-76SF00098, for the HIF Virtual National Laboratory.

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